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Research for Ultra-low Emissions Diesel Engine Two-valve Control Fuel System

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Abstract

To carry out ultra-low emission for diesel engine, a new technology is presented. ECU control circuit for the dual-solenoid valve system was built and experimental control interface were designed. Three conditions experiments are finished:(1)Conditions of the regulation characteristics of the same target;(2) Performance of low-speed high-pressure injection;(3) Loop between the dynamic regulation performance . Results show that double solenoid valve system on the same target conditions can be quickly and easily change the injection characteristics, enhanced fuel injection characteristics of the controllability of the system; through the two valves are open and flexible combination of timing control, low speed engine , they can easily achieve high-pressure fuel injection; by changing the control valve and the duration of time, two-valve system can be quickly and flexibly adjust the diesel engine fuel injection characteristics of each work cycle to meet the needs of the engine in different conditions , and can greatly improve engine performance and achieve ultra-low emissions.

Keywords: two-valves; control characteristics;low-speed jet;ultra-low emissions

1. Introduction

At present, most diesel engine production is the high pressure common rail injection system, a small electronic unit pump system by basically not using electronically controlled pump nozzle injection technology, at this stage almost all light duty diesel engine using high-pressure common-rail injection system medium and heavy diesel engines are used EUP and two electronically controlled common rail injection system technology[1]. Some of our universities and companies have been working on diesel engine fuel system in the key technology[2]. Tianjin University and other universities and colleges of high pressure common rail fuel system has made more progress, in a leading position; in the electronic unit pump fuel system, the main focus at the Beijing Polytechnic University and Tsinghua University. At

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present, the fuel system of production units is in Chengdu and Wuxi Fuel Injection Equipment Witt Research Institute. Chengdu Weite EFI Company and Tsinghua University in 2004, successfully developed a proprietary electronic unit pump systems, and in that year began to offer suite of products for heavy vehicles, has provided thousands of sets of products, become the first production diesel engine electronic fuel injection systems products business, FAW Group, Institute of Wuxi Fuel Injection is also entirely on its own success and in 2005 developed the first generation with independent intellectual property rights of electronically controlled common rail fuel injection system, but No large-scale commercial applications. Scientists of the same internal combustion engine industry will be as the internal combustion engine fuel system of one of the key areas of research. Among them, the university based in the fuel system typical of the work carried out by common include: irregular injection fuel system mechanism was discussed in detail, the fuel system in the short survival of the bubble properties are studied, the new structure proposed injector and spray characteristics of the device. Electronically controlled high pressure fuel system for the major domestic use of the existing conventional single valve in the fuel system research, the main object of study is the electronic unit pump and high-pressure common rail fuel system[3]. The work carried out to promote the development of internal combustion engine fuel system, making the country has been following the foreign advanced technology [4- 7]. Due to the current lack of independent intellectual property rights of electronically controlled high pressure fuel system is currently China's scientific research institutions and enterprises of the future research in the field of fuel system, carried out mainly in the research of piezoelectric crystal injector, while the two-valve Fuel System lagging behind, so for the dual-valve fuel strong high pressure system in the transient process of basic research carried out less, the fuel system of the present study also focused on a single stage of the fuel system valves, double valve not yet carried out future-oriented advanced fuel system of the lag in this area will affect the future of our fuel system further rapid development. Since the fuel system is a double valve subsystem and management by a number of sections of pipe thermal fluid systems, in-depth study of the system will be based on fundamental equations of fluid heat, detailed analysis of the principle of double-valve system, the establishment of the system utility physical model, using the corresponding computational simulation software performance computing, through the full feasibility of the experimental simulation experiments, and the model is improved[8-11] As the current international fuel AMESIM flow simulation software, mainly for the French, and the software supports the user's secondary program, and under different conditions to calculate the temperature of the system and be able to on the flow parameters to the physical characteristics of the media table manner consideration, so the project can meet the two-valve fuel system performance calculation. In the simulation may encounter some practical and reasonable value of physical constants determined machine parameters, these parameters are related to the fuel through the Experimental Analysis Unit to get help. Double-valve fuel system of the industrial sector from abroad, its findings are confidential, some universities abroad has just begun to explore the domestic academia and industry have not yet carried out a double-valve for the Wizard of future advanced fuel system. China's current fuel system design and processing technology is relatively backward, especially in the pump nozzle in China is still not practical, so China can not copy the development of foreign technology, China's national conditions need to be explored to meet the new fuel system. In this paper, existing traditional electronic unit pump and common rail injector constructed a new dual-solenoid valve fuel system.

2. Test system

The experiment used the latter program. Test high-speed acquisition system with INOV8 (Figure 1) were collected tubing pump testing and end pressure, nozzle end pressure, dual-valve drive current, drive, and fantasy fuel supply control signals and other signals. The fuel system uses a single cylinder of a pump

tubing pump to generate high-pressure fuel within the fuel system control unit pump installed in the main pump through the side of the relief valve (SV valves) and installed in the common rail injector nozzle side needle control valve (NCV valve) to achieve. SV valve control oil which, through the NCV valve to achieve the electronic control fuel injection. The fuel system uses a single cylinder of a pump tubing pump to generate high-pressure fuel within the fuel system control unit pump installed in the main pump through the side of the relief valve (SV valves) and installed in the common rail injector nozzle side needle control valve (NCV valve) to achieve. SV valve control oil which, through the NCV valve to achieve the electronic control fuel injection. In this study, dual-fuel system solenoid valve SV is normally open; NCV valve is normally closed, then if the valve has been for normally open or normally closed, would constitute Four control combinations.

(1) NCV Section of the valve section containing the work of SV valve

SV in the relief valve during the valve closed, NCV valve is always open, that is, before the fuel supply unit pump start, NCV valve is opened, when the pressure increases to a certain value, to overcome the valve's return spring preload , open the fuel injection valve so that the fuel injection system is entirely dependent on the return spring preload. The working mode is regular table in the jet model. At this time entirely on the mouth end of the valve return spring to determine the characteristics of valve opening and closing of pressure on the operating characteristics similar to conventional fully electronic unit pump fuel system.

(2) NCV valve SV valve is working before

In this way, NCV valve effect of the time before the start valve SV, and stopping time later than the SV valve, so in this way, the injector opening and closure of the SV valve nozzle spring decision, and fuel injection NCV valve closed by the end of the decision.

(3) NCV work later than SV

NCV valve is open in the SV before the valve is opened; high-pressure fuel pump will produce until the NCV valve opening start injector nozzle. At this time, NCV valve is opened and the SV valve closed time interval between the openings will determine the injection pressure and injection process, the average injection pressure. Fuel injection valve opening is determined by the NCV, the end of the SV valve to stop fuel injection time and the nozzle spring decision.

(4) SV, including the work NCV

In this manner, the NCV valve segments in the entire work, SV valve has been in working condition, so when the start and end fuel injection system by the NCV valve to control, and spraying to keep the valve closed SV NCV valve is closed, then the needle will remain after the closure of the tubing pressure, provide the conditions for the next injection, then re-open if the NCV valve will be able to spray again in order to achieve multiple injection.

Figure 1 INOV8 high-speed acquisition

3. Discussions

In this study, dual-solenoid valve system, the use of two solenoid valves for fuel injection control, oil supply can be carried out separately and the flexibility to control fuel injection, through a combination of the two solenoid valve controls can be flexible and precise control of injection pressure, spray oil.

3.1 Performance of low-speed high-pressure injection

Figure 2 shows the characteristics of the same target of several experimental conditions mediation pipeline pressure curve. The impact of the SV valve allows the valve to the NCV corresponding period of the tubing to control the pressure difference and the maximum pressure difference between the larger tubing. With the tubing pressure, in order to maintain the same target cycle duration of valve oil NCV decreases. The injection pressure and duration are different, so the pressure of several injection valves are not the same as Kai, injection is not the same law. The results show that at the same speed, by changing the SV valve timing and duration, and NCV valve duration, can maintain the injection timing and conditions of different characteristics were the same fuel injection quantity, so in the same condition injection characteristics to achieve flexible, so double-solenoid valve system has a very good regulation characteristics and control flexibility.

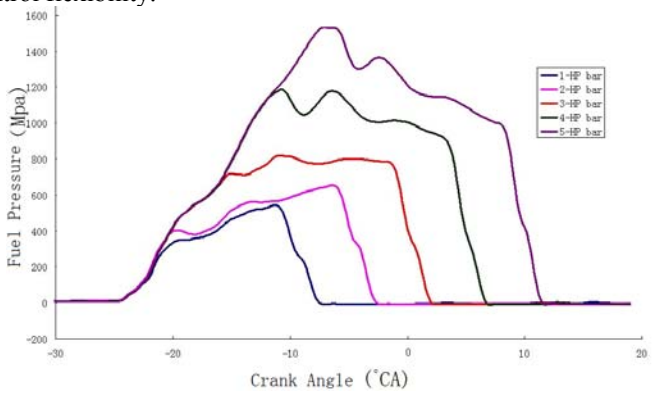
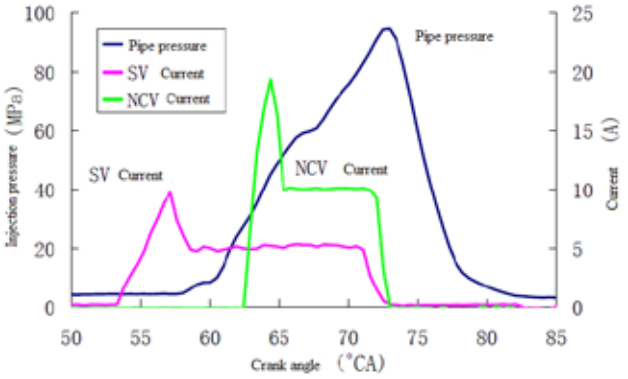


Figure 2 Comparison of Figure tubing pressure

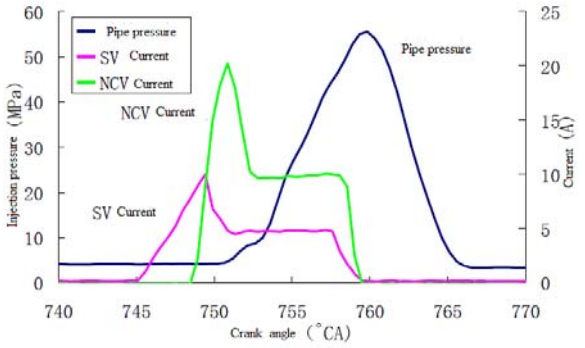
3.2 Loop between the dynamic regulation performance

Shown in Figure 3(a), SV valve opening time, NCV and then open the valve, through two solenoid valves to control opening and duration, so that pre-spray combustion effect, this will help fuel burning more fully on the power of the increase will certainly help. And reduce harmful gas emissions. Figure 5(b) SV valve opens when the drive current reaches the maximum when the NCV valve opening, when the tubing pressure is relatively small, the relative fuel consumption is also reduced, road conditions more suitable for this more complex situation, so as to achieve slow speed and fuel purposes. This control is a single valve can not do.

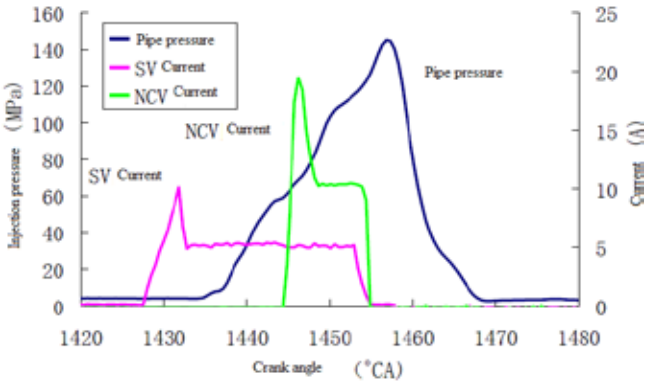
Figure 5(c) shows, when the SV valve opens and continue for some time, NCV and then open the valve and two solenoid valves and closing the valve through the dual control, the two pre-spray combustion processes, injection pressure significantly improved so that , which is conducive to the full combustion of fuel, is conducive to the improvement of dynamic, as well as the effects of jet lag and improve the engine's combustion efficiency and reduce soot emissions.



(a) Cycle 1



(b) Cycle 2



(c) Cycle 3

Figure3 Two-valve Control way and fuel injection pressure

4. Conclusions

Completed a double-solenoid valve system features a series of bench experiment and verification, obtained dual-solenoid valve system has excellent characteristics of the following aspects:

(1) Double solenoid valve system controlled by two solenoid valves can supply diesel engine and fuel injection on a separate control. On the same target conditions can be quickly and easily change the injection characteristics, enhanced fuel injection characteristics of the controlled system, while greatly increased the flexibility of the control of diesel engine fuel system.

(2) Experiment proved, through the two valves open and flexible combination of timing control, at low engine speeds, they can easily achieve high-pressure fuel injection, which can greatly improve engine performance and low emissions.

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